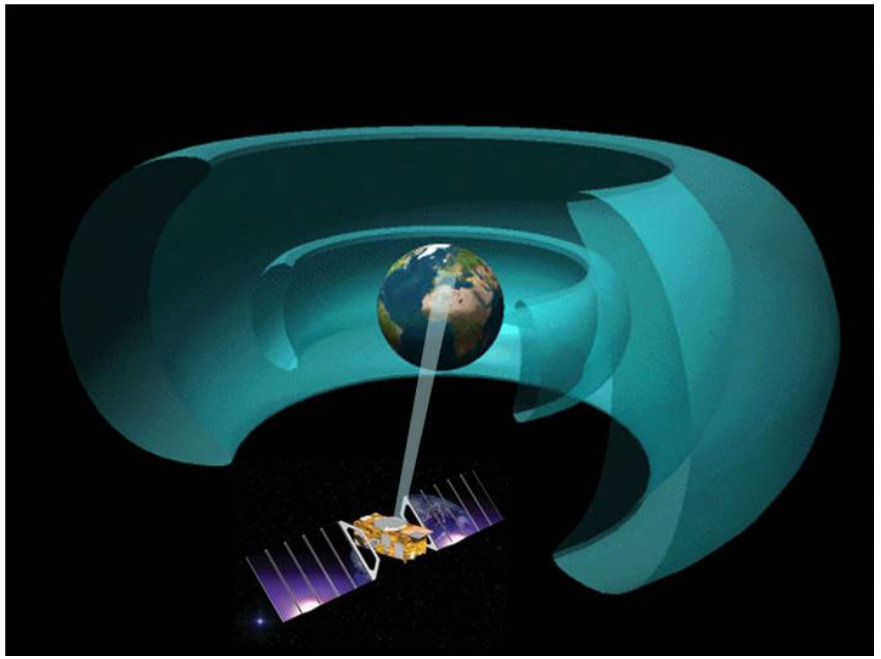
ESA Report to ISES - 2015

(**C**ollaborative **E**xpert **C**entre of ISES)

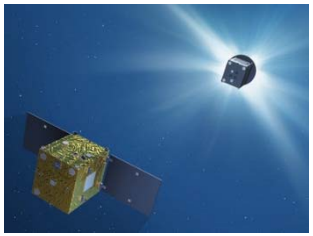
Duties of collaborative expert centres (Bylaw #3) :

- Encourage and support development of space weather services
- Contribute expertise in space weather forecasting
- Promote space weather services in centers not affiliated with ISES.



Content

1. ESA Technology R&D activities



2. Space weather coordination activities in Europe

1. ESA Technology R&D activities in space weather

- Spread over several TR&D programmes:
  - Generic:
    - General Study Programme (concept),
    - Basic Technology Research Programme (breadboard),
    - General Support Technology Programme (prototype)
  - Programme related: Science, Telecom, Galileo,, etc…

Highlights 2014: Modelling and data systems

- Environment modelling for engineering:
  - Development of flare, CME and SEP forecasting techniques
  - Prototyping a Virtual Space Weather Modelling Centre (VSWMC)
  - Jupiter/Mars/Moon radiation, plasma, atmospheric and dust environment
  - Exploitation of scientific data (e.g., Cluster)

- Engineering and analysis tools
  - Development of SPENVIS framework next generation
  - plasma interactions effects mainly in SPIS framework
  - Space debris/meteoroid risk analysis

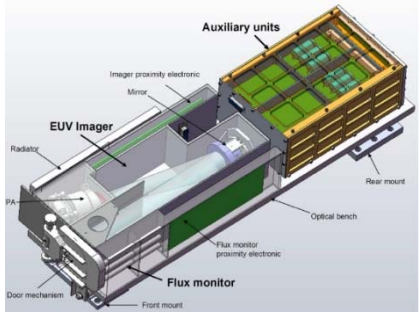
- Monitoring tools
  - SEISOP – s/c anomaly monitoring
  - MONITOR, ionosphere

Technology R&D: Environment monitors

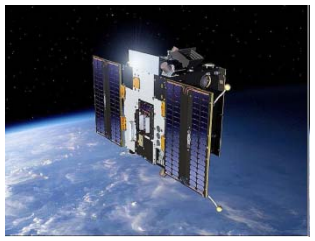
- Radiation monitors
  - Old instruments: REM, SREM
  - High energy particle spectrometers (on Proba-V, 2013)
  - NGRM – completed – planned for EDRS1
  - HMRM – first version on TechDemoSat
  - 3DEES – Qualification nearly completed

- Plasma monitors
  - Plasma-spectrometer – Hope – QR nearly complete
  - Plasma wave spectrometry – initial design complete

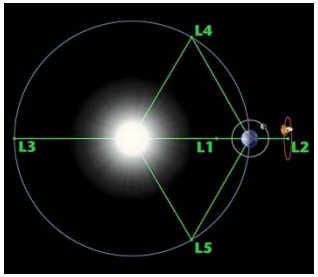
- Other:
  - EUV solar imager – in progress – QR this year
  - Magnetometers – QR completed (planned for Kompsat2A)
  - GPS receiver in radio occultation mode (GRAS-2 on METOP-SG)
  - Micro-particle detector (QR completed)
  - Impact detection via plasma signature (initial design complete)
  - Coronagraph (To be initiated this year)



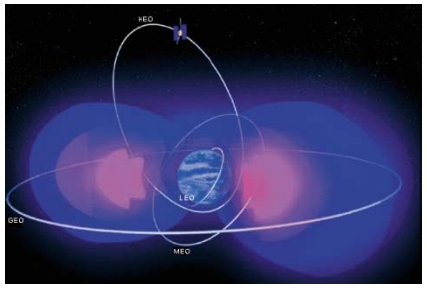
Technology R&D: Environment monitors



- Small technology satellites:
  - PROBA-1/radiation monitor auxiliary payload
  - PROBA-2/Solar observation payload and Plasma payload
  - PROBA-V (radiation monitor, EPT)
  - **PROBA-3**: (Main secondary: coronagraph + may have swe package)



- Space weather piggyback payloads on scientific satellites :
  - XMM, Integral (HEO), Rosetta (interpl), hershel, planck (L2)
  - SWARM/Various
  - Future: JUICE, SolarOrbiter, Athena



- Space environment payloads on operational satellites :
  - Giove-A, Giove-B (rad monitors)
  - Metop-A, B, **C**/SEM
  - Alphasat, rad monitor (MFS)
  - **Galileo FOC/Radiation monitor (EMU)**
  - **Meteosat Third Generation / NGRM**
  - **Kompsat2A, Magnetometer**
  - **Metop SG/GRAS-2, radiation & charging monitor**

- **Other piggyback opportunities under investigation**.

Space Weather TR&D Activities Roadmap

- Context:
  - EC covers research activities to strengthen scientific capabilities.
  - The Space weather domain R&D activities are significantly driven by the SSA programme needs.
    - Precursor services
    - Observation system (including several flight opportunities: EDRS, Metop-SG, Galileo, Alphabus, …).
  - SSA phase 2 programme includes various instrument procurements and developments.
  - Other service domains address space weather needs in complementarity.
  - Cross-cutting TR&D theme, ‘Space and Energy’ includes space weather.

2. Space weather coordination activities

- Space weather service development European coordination:
  - SWWT established in 2000 provide guidance to ESA and EU wide coordination.
  - **Coordination with EC research programme (several calls – many activities)**

- Space weather international collaborations:
  - **Bi-laterals (e.g., NOAA-ESA, US-ESA, KHU-ESA)**
  - **COSPAR**
  - **ILWS**
  - **ISES**
  - **WMO**

- ESA Space weather programme (part of SSA):
  - Space situational awareness preparatory programme: 2009-2012
  - Space situational awareness phase 2: 2013-2016 in progress
  - Space situational awareness phase 3: 2017-2020 in preparation

SSA Programme

Objective: establish operational capacity in Space Situational Awareness within 2009-2019.

Phase 1: Preparatory Programme [2009-2012]

- User needs and system requirements analysis
- Service prototyping.

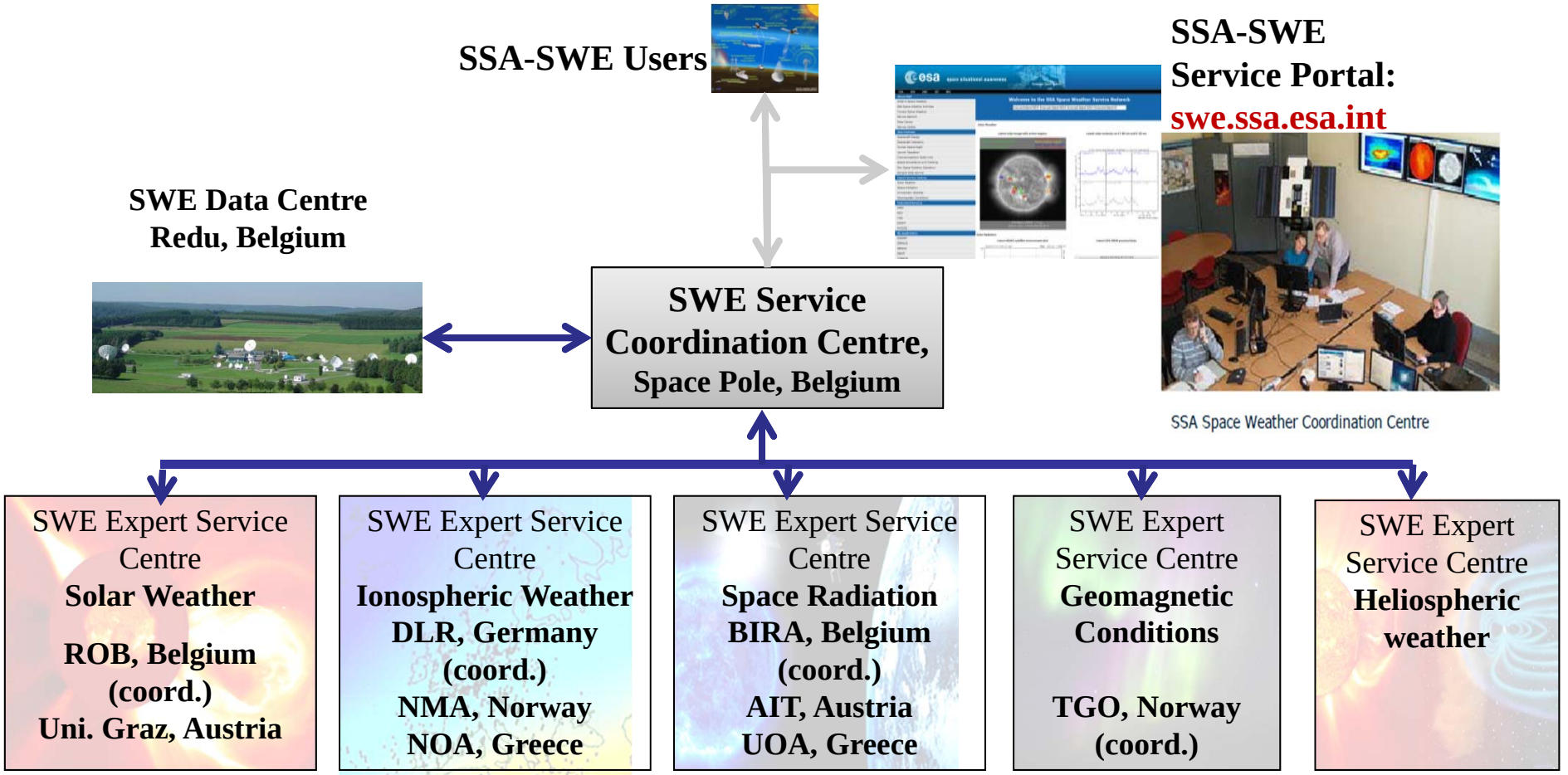
Intermediate phases (2013 – 2019):

Operational system development

Final phase:

Transfer to an operator

Precursor service segment



SSA phase 2 highlights

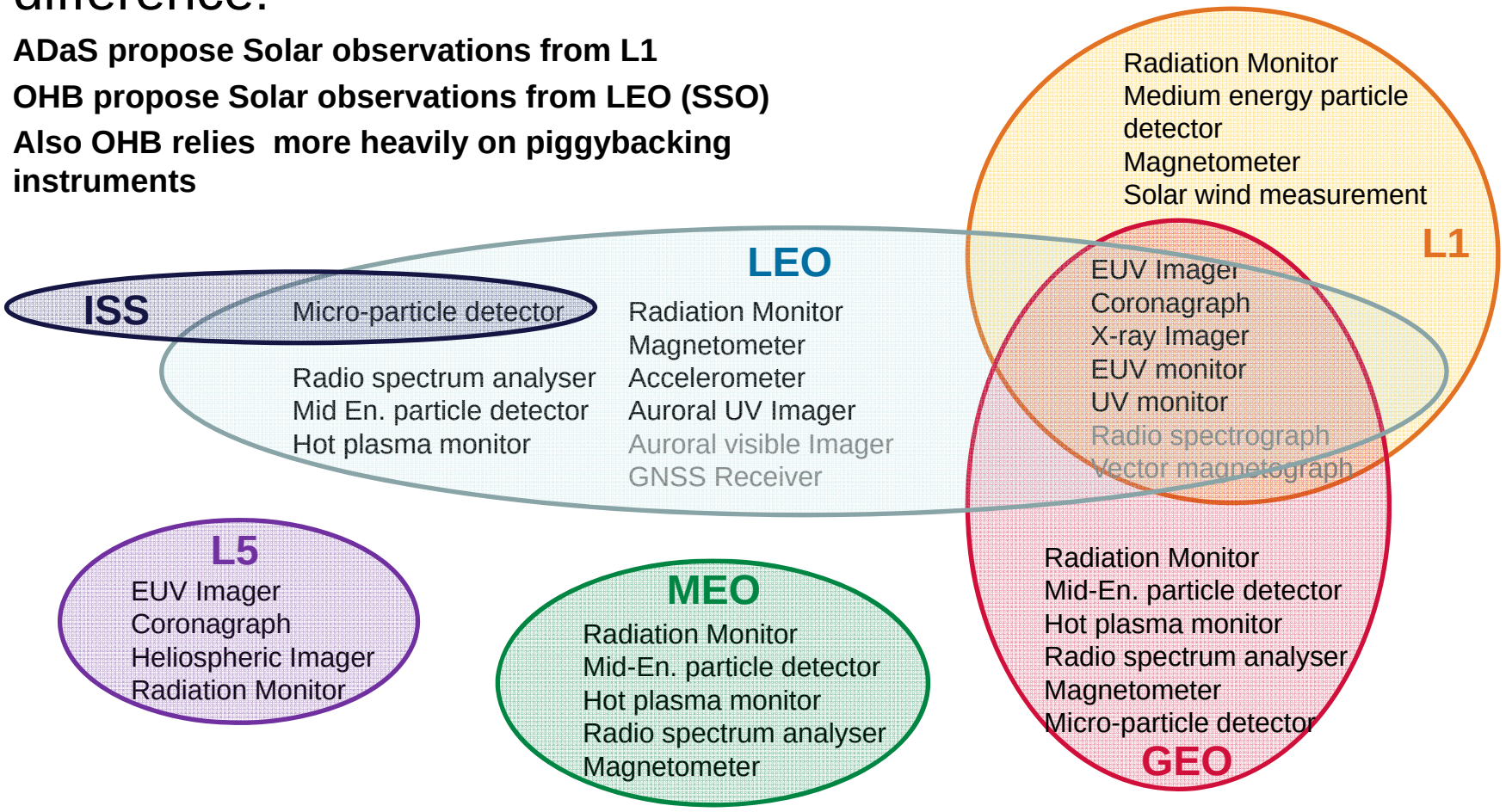
- Development of the SSCC and the expert centres and associated services
- Proba-2 operations
- Definition of global architecture including observing system
- L1 and L5 phase 0 study just starting
- Instrument procurements:
  - NGRM on EDRS
  - SOSMAG on Kompsat2A as part of KSEM
  - HOPE (Hot Plasma Environment)
  - 3DESS (high energy particle spectrometer)
- Cost benefit analysis
- Preparation of next phase

Results of // architecture studies are broadly similar but with one major difference:

ADaS propose Solar observations from L1

OHB propose Solar observations from LEO (SSO)

Also OHB relies more heavily on piggybacking instruments



Conclusions

- TR&D in space environment and effects (ESA+EC) is continuing and support ESA activities as collaborative expert centre of ISES.
- It is currently strongly stimulated by SSA programme but also by other programmes.
- SSA programme is preparing for a full blown operational European space weather application system.
  - Main European RWC involved currently: RoB [B].
  - Investigation of other RWC (Cz, Pol, SE) and other space weather centres (A, Can, D, Dk, E, F, Fin, N, UK, Rm, …) participation is ongoing.
- Other relevant programmes include:
  - Galileo
  - Space & energy